

## TECHNICAL DOCUMENTATION

### APPENDIX C.

# Accuracy of the Data

## SAMPLE DESIGN, ESTIMATION AND ERRORS

### A. INTRODUCTION

This documentation explains the sample design, *estimation procedure*, known *sources of error* and estimates of error for the American Travel Survey. It illustrates how to use estimates of sampling error to create confidence intervals, and enables the data user to be confident that he/she is using the data accurately.

The data presented in this publication are based on a sample of households, group quarters, such as, dormitories, religious group dwellings, and family-type housing on military bases. Military barracks and institutions, such as prisons and nursing homes, are excluded. The data shown are estimates of the values that would have been obtained if each household in the country had been interviewed. Estimates are expected to be subject to two basic types of error—sampling error and nonsampling error. These two types of error are explained in later sections of this documentation.

### B. SAMPLE DESIGN

The American Travel Survey (ATS) sample is a state-based design of approximately 80,000 addresses from the 1980-based Current Population Survey (CPS) sample. The sample size, which differs by state, was selected to ensure that reliable state estimates could be made. The sample was selected in two stages.

#### 1. Selection of Sample Areas for CPS

The first stage was the selection of a sample of 729 geographic areas known as Primary Sampling Units (PSUs). PSUs were formed by dividing the United States into 1,973 areas made up of counties (or minor civil divisions in New England and Hawaii). Of these PSUs, 314 were in sample with certainty because of their large populations. These 314 PSUs are known as self-representing (SR).

The remaining 1,659 PSUs were divided into 415 groups or strata based on demographic and economic characteristics (population growth, proportions of blacks and Hispanics in certain states, and distribution of the population by occupation, industry, age and sex). These strata were formed within state. Within each stratum, probabilities were assigned to each PSU proportionate to the total population as of the 1980 census. One PSU was then selected from each stratum. These PSUs are referred to as non-self-representing (NSR), since the sample of households from a single sample PSU represents all of the households in the stratum from which the PSU was selected.



## 2. Selection of Clusters of Sample Addresses for CPS

The section stage, involved several steps to select the addresses to be enumerated within each sample PSU in the CPS. First, the 1980 census enumeration districts (EDs), which are administrative units and contain an average of about 300 addresses, were sorted geographically. Within the geographic sort, the EDs were ordered so the sample would reflect the demographic and residential characteristics of the PSU. Within each sample ED where 1980 census addresses were complete and where new construction is governed by building permits, the 1980 census addresses were sorted geographically and grouped into clusters of approximately four neighboring addresses. Next, clusters of addresses were selected systematically with sampling intervals varying by state. The CPS actually selected 20 samples at one time. Thus, the next 19 consecutive clusters were also selected at each sample cluster. Sampling intervals were adjusted within NSR PSUs by multiplying the sampling interval of the state by the NSR PSU probability of selection.

Clusters of new construction since the 1980 census were also formed from lists of building permits issued. In sample EDs where 1980 census addresses were not complete or where new construction is not governed by building permits (area EDs), a sample of land areas was selected. Field representatives listed all addresses (i.e., 1980 census addresses, as well as addresses built since the census) currently in these sample land areas. Clusters of addresses were systematically selected from these listings. In areas that issue building permits, non-mobile homes built since the 1980 census were screened out.

## 3. Selection of Clusters of CPS Sample Addresses for ATS

Because the sample design is state based, the sample size differs by state and depends on the reliability requirements for each state as well as the travel patterns for the state. Our ultimate goal for the ATS was a sample of trips at least 100 miles in length, one way, that met our reliability requirements. Since the universe of trips of this length varied by state, it was necessary to select different size samples for each state to meet the reliability requirements for a given state. In general, the reliability requirements were the same for all states.

The ATS sample was selected by sampling the CPS clusters from the most recently retired CPS samples available. For many states, it was necessary to select from all or part of several CPS samples. This means that several adjacent CPS clusters were selected for the ATS. In these states, the average ATS cluster size of neighboring addresses was larger than 4. See Table C-2 for an estimate of this average cluster size for each state.

The ATS did not update the new construction in CPS that was selected from the building permit sample or the area EDs. Consequently, the ATS does not have a complete sample of new construction in its sample areas.

## 4. Assignment to Interview Group

The survey, which is primarily a telephone interview survey, employed a split-sample design with cases in each CPS PSU being assigned for interview at the Census Bureau's three telephone centers (centralized CATI) or in the field. The cases assigned to interviewers in the field using laptop computers could be done by telephone (decentralized CATI) or by personal visit (CAPI). About 45,000 cases were assigned to centralized CATI and 35,000 were assigned to decentralized CATI/CAPI.

In January and February of 1995, interviewers at the telephone centers contacted the ATS households by telephone and conducted the Post Mail Initial Call Screener (PMICS) operation. During this call, the interviewers verified the sample address and telephone number. PMICS also tried to obtain correct telephone numbers for cases that had incorrect telephone numbers.

Some households could not be reached by telephone. Consequently, before assignment to an interview group, the sample was divided into the "good" and "bad" phone strata based on the PMICS results. If a sample address had a valid phone number it was placed into the "good" phone stratum. All other households were placed into the "bad" phone stratum.

In order to increase the number of "good" stratum cases, additional retired CPS sample cases which were last interviewed in January, February, July, August, September and October 1994 were added. This is referred to as the "new" sample. Since this sample was added late, these cases did not go through the PMICS operation. Cases that had a CPS phone number were put into the "good" stratum since the phone numbers were expected to be fairly accurate. The remaining cases were put into the "bad" stratum. Table C-1 shows the distribution of the sample by "good" and "bad" strata within the old (i.e., the ATS sample that went through PMICS) and new sample.

**Table C-1: Distribution of ATS Sample by Strata and Sample**

Sample	Strata		Total
	Good	Bad	
Old	50522	10537	61059
New	17662	1444	19106
Total	68184	11981	80165

Two-thirds of the cases in the “good” stratum were sent to centralized CATI and the remainder were sent to decentralized CATI/CAPI. One-fourth of the cases in the “bad” stratum were sent to decentralized CATI/CAPI. The remaining units in the “bad” stratum were not sent for interview. Therefore, the weights on the decentralized CATI/CAPI cases in the “bad” stratum were increased to represent the cases from the “bad” stratum that were not used.

Each ATS sample household was interviewed three or four times from April 1995 to March 1996 in order to collect information about each household’s travel for all of 1995. Each of these interviews, called a cycle, concentrated on trips taken during the reference period. The first interview uses January 1 to the date of the first interview as the reference period. For subsequent interviews, the reference period was defined as the date of the previous interview to the date of the current interview.

Within each cycle the sample was divided into three representative samples called waves. A sample unit assigned to a wave stayed in the same wave throughout the duration of the survey. Each wave was interviewed in a different month of the cycle to spread out the interviewing and processing workloads, as well as to even out the effect of recall on the sample results.

The telephone centers attempted to complete CATI interviews with as many of their cases as possible. Cases that the telephone centers could not interview were not sent out to the field for interview (i.e., recycled) as is typically done for Census Bureau surveys that conduct interviews from the telephone centers. The weight on some of the cases assigned to decentralized CATI/CAPI was adjusted to represent the cases the telephone centers did not interview. To ensure the comparability of the centralized and decentralized components, a maximum CATI approach was used from the interviewers’ homes. The field interviewers were given some guidelines to use so their workloads would be completed using methods as similar as possible to the procedures used at the telephone centers.

## 5. Sample Size and Interview Results

Of the 80,000 addresses in sample, 61,000 were selected from the old sample and 19,000 were selected from the new sample. Table C-2 contains the number of interviews in each state by cycle. Table C-3 presents the results of the cycle interviewing at the national level for centralized CATI and decentralized CATI/CAPI, respectively. Households assigned to wave 3 completed their interviewing in three interviews instead of four. This accounts for the lower number of sample cases displayed in these tables for the fourth cycle.

**Table C-2. Average Cluster Size and the Number of Interviews by Cycle for Each State**

State	Interviews in each cycle				Average Cluster Size
	1	2	3	4	
Alabama	1374	1326	1322	861	11.0
Alaska	1154	1100	1074	674	11.0
Arizona	1093	1058	1078	700	12.0
Arkansas	1087	1058	1051	678	8.5
California	911	890	861	518	4.0
Colorado	1139	1127	1119	708	11.0
Connecticut	1269	1243	1238	789	15.5
Delaware	1073	1076	1062	688	14.0
District of Columbia	898	945	929	576	12.0
Florida	1532	1504	1520	951	4.5
Georgia	1195	1171	1156	766	11.5
Hawaii	1157	1121	1099	705	15.0
Idaho	1226	1210	1177	754	9.0
Illinois	1119	1079	1086	682	4.0
Indiana	1281	1260	1250	811	12.0
Iowa	1098	1087	1073	693	8.0
Kansas	1291	1249	1246	812	10.0
Kentucky	1539	1522	1538	989	13.0
Louisiana	1162	1119	1137	707	12.0
Maine	1536	1511	1486	938	16.0
Maryland	1102	1127	1092	713	11.5
Massachusetts	1233	1211	1210	749	4.0
Michigan	1052	1029	1015	655	4.0
Minnesota	962	936	941	591	8.5
Mississippi	1679	1624	1621	1024	13.0
Missouri	1273	1203	1201	782	10.5
Montana	1117	1087	1069	673	8.5
Nebraska	1011	1033	1016	662	7.5
Nevada	1041	1033	999	661	11.0
New Hampshire	1603	1595	1575	1004	21.0
New Jersey	1357	1340	1328	858	4.0
New Mexico	1088	1081	1035	682	11.5
New York	1245	1216	1191	762	4.0
North Carolina	1062	1034	1028	665	4.0
North Dakota	1030	1019	1001	630	7.5
Ohio	1288	1257	1239	809	4.0
Oklahoma	1023	986	975	638	9.0
Oregon	1037	995	977	620	10.5
Pennsylvania	1376	1368	1348	877	4.0
Rhode Island	1563	1549	1541	978	20.0
South Carolina	1102	1094	1110	704	9.0
South Dakota	980	987	978	623	6.5
Tennessee	1330	1302	1272	843	10.5
Texas	1022	1018	1012	649	4.0
Utah	1275	1256	1254	818	13.5

State	Interviews in each cycle				Average Cluster Size
	1	2	3	4	
Vermont	1560	1521	1494	962	19.5
Virginia	1098	1083	1087	696	8.5
Washington	1091	1054	1039	677	11.0
West Virginia	1123	1107	1098	736	9.0
Wisconsin	1148	1131	1126	732	7.5
Wyoming	1170	1177	1138	736	13.5
<b>Total</b>	<b>61175</b>	<b>60109</b>	<b>59512</b>	<b>38209</b>	

Table C-3: ATS Sample by CATI or CATI/CAPI and Cycle

Cycle	Centralized CATI			Decentralized CATI/CAPI			
	IVs	NIVs	Total	IVs	Eligible NIVs <sup>1</sup>	Inelig. NIVs <sup>2</sup>	Total
1	34680	10303	44983	26495	3734	4953	35182
2	33436	11547	44983	26673	3526	4983	35182
3	32835	12148	44983	26677	3575	4930	35182
4	21093	8462	29555	17116	2382	3384	22882

**NOTES:**

1 Units which were eligible for interview but their data was not collected (e.g., no one home, refusals, etc.).

2 Units which were not eligible for interview (e.g., unit demolished, vacant, etc.).

**C. ESTIMATION**

The household-trip and person-trip weights were derived as a product of the inverse of the probability of selection of the sample household and several weighting factors which accounted for noninterviews, household under coverage, within-household under coverage and trip under reporting.

Weighting factors were computed and applied separately within each cycle. Most of the weighting factors were computed at the household level and applied to all corresponding household and person trips that were reported by a particular household. Some of the factors were computed at the person level and only applied to certain household and person trips. The remaining factors were computed at the trip level and applied to specific household and person trips. The types of household and person trips to receive these factors will be defined in the following sections that describe the factors.

Initially, because of differences between the old and new sample in the classification of “good/bad” phone strata the probability of selection was calculated for each sample separately. An adjustment to this probability was made to building-permit/new-construction sample households to account for some of the building-permit/new construction not included in the ATS sample. After adjusting for household level noninterviews, a combining-samples factor was calculated at the state level that reduced the weights of both the old and new samples so they could be combined to produce the ATS estimates.

**1. Noninterview Adjustments**

Four different adjustments were made for households (or persons) that could not be interviewed. For each of these adjustments, factors were computed for a set of cells. The numerator of the factor was the weighted count of interviews and noninterviews in a given cell. The denominator was the weighted count of interviews in the same cell.

• The *first noninterview adjustment* adjusted for the households sent to the phone centers (centralized CATI cases) which were not interviewed. The centralized CATI noninterviews were made up of three types of units: (a) units that would have been interviewed if personal visits were made, (b) units that were eligible for interview but their data was not collected (e.g., refusals), and (c) units ineligible for interview (e.g., vacant). Since it was not known whether or not the centralized CATI noninterviews were eligible for interview, this adjustment involved applying greater weight to both interviews and noninterviews from the decentralized CATI/CAPI cases in the “good” stratum.

The decentralized CATI/CAPI cases that were used to represent the centralized CATI noninterviews were selected based on characteristics that would have made them unlikely for the phone centers to have been able to complete an interview. These characteristics include those not accessible by phone (no phone or incorrect or missing phone number), persons who refused by phone or requested/required a personal visit interview, vacant, etc.

Because of our sample design, this adjustment for the centralized CATI noninterviews was a critical part of our estimation system. Consequently, special procedures were put into place to aid in identification of the appropriate decentralized CATI/CAPI cases to include in the adjustment. The mode of interview (personal visit or telephone), the reason for a personal visit, and the source of the phone number was captured. In addition, if the phone number recorded in the interview was different from the one the interviewer was given by headquarters, the case was sent to a telephone look-up operation at the centralized CATI facility to see if they could find the correct phone number.

After these cases were identified, they were assigned to the appropriate cells for the adjustment. Cells were based on state, wave and sample (old and new). This adjustment was done at the household level.

• The *second noninterview adjustment* adjusted for decentralized CATI/CAPI noninterviews that were eligible for interview but the respondents refused, were not home after repeated visits, or were unavailable for other reasons.

This adjustment was applied to all interviews from both the centralized CATI and the decentralized CATI/CAPI samples. Cells for sample households in the “good” stratum in the old sample were based on state, wave, CPS income, and metropolitan statistical area status. Cells for the remaining households were based on state, wave, CPS income and sample. This adjustment was done at the household level.

- The *third noninterview adjustment* adjusted for interviewed households known to have traveled, but were dropped because of missing or inadequate trip information. This factor increased the weight of the centralized CATI and decentralized CATI/CAPI traveling households which had adequate trip data to represent households that did not have valid trip data. Cells for traveling households in the “good” stratum in the old sample were based on state, wave, ATS income, and metropolitan statistical area status. Cells for the remaining traveling households were based on state, wave and sample. This adjustment was done at the household level.

- The *fourth noninterview adjustment* was implemented after samples were combined and the household level weights were computed. This adjustment was done at the person level for households where some members were interviewed but others were not. The cells were based on state. This adjustment accounted for certain types of trips taken by persons who were known to live in the household during the reference period, but who were not available to be interviewed. It was assumed that if these persons took trips with other household members, the trip would have been reported by one of them. Therefore, this factor was only applied to trips that did not include any other household members (single-person household trips).

## 2. Ratio Estimation Factors

The ratio estimation factors adjusted the sample to better reflect the universe from which the sample was selected and to adjust for missed household-trips and person-trips due to household and person under coverage.

- The *first ratio estimation factor* reduced the contribution to variance that results from selecting a sample of PSUs rather than drawing sample households from every PSU in the nation. The cells were based on state and race (black/nonblack). It was applied to PSUs that are not self-representing in states that have a substantial number of black households. The procedure accounted for differences that existed at the time of the 1980 census between the race distribution of the sample PSUs in the state that were not self-representing and the race distribution of all PSUs in the universe that were not self-representing. This adjustment was applied at the household level.

- The *second ratio estimation factor* adjusted the sample to better reflect the total number of households within each age of reference person and tenure cell in a state. This corrects for missed household-trips and person-trips due to household under coverage caused by deficiencies in our original sampling lists, as well as possible survey error caused by data collection and incorrect processing assumptions. Independent household controls were prepared by applying a state household formation rate by age of householder. This rate was derived from the change in householder rates (obtained from CPS data) from 1990 to the estimate date and home-ownership rates obtained from the Housing Vacancy Survey. The methodology for total household estimates is described in detail in Current Population Reports, Series P-25, No. 1123 (U.S. Bureau of the Census). A similar methodology was used for household estimates by tenure. These estimates served as the numerator for this factor.

Household interviews were grouped into cells by state, age of reference person and tenure. The weighted count of these sample units using the inverse of the probability of selection and all previous factors, excluding the fourth noninterview adjustment, served as the denominator. The resulting factor was applied at the household level.

- The *third ratio estimation factor* adjusted the sample to better reflect the total number of persons within each age and sex cell in a state. This corrects for missed household-trips and person-trips due to person under coverage within households. Independent population controls were obtained from the resident part of the state, age, and sex estimates program described in U. S. Bureau of the Census, Current Population Reports, Series P-25, No. 1127. This program updates census data with information from a variety of other data sources that account for births, deaths and net migration. Estimated numbers of resident Armed Forces personnel and institutionalized persons reduce the resident population to the civilian noninstitutional population. Estimates of net census undercount, determined from the Post Enumeration Survey, are added to population estimates.

The method used in this adjustment assumed that all persons with a given age/race/sex do not have an equal chance of being missed. In particular, it assumed that the reference person and his /her spouse were always picked up by the survey if the household was interviewed (i.e., only persons other than reference persons or spouses could be missed in interviewed households). Thus, the numerator of the ratio equaled the independent estimate of the civilian noninstitutional persons in the cell minus the ATS sample estimate of reference persons and spouses. The denominator of the ratio equaled the ATS sample estimate of persons



in the cell, excluding references persons, their spouses and persons in the military.

This factor was done in two steps, first by grouping the sample persons into cells by age and sex within state and computing the initial factor. After applying the initial factor, the persons were then regrouped into cells by age, sex, Hispanic origin and black/nonblack for the total USA. This process was repeated to bring the ATS sample estimates into closer agreement with both sets of independent estimates.

The final version of the third ratio estimation factor, which was the product of all iterations of the state and U.S. factors, was applied to all person-trips reported by persons (including military) who were not reference persons or their spouses. It was also applied to all of their single-person household trips. It was only applied to their single-person household trips because it was assumed that trips taken with other household members would have been reported by one of them.

### 3. Trip Adjustment Factors

The trip adjustment factors were applied to specific trips and attempted to account for aspects of the ATS that could result in the under coverage of these trips.

- The *proxy adjustment factor* adjusted for trips that were missed because the ATS generally collected the travel information for the entire household from one household member — the proxy respondent. When a sample of households were reinterviewed for response error measurement, more trips were reported during the reinterview than the initial interview. Research showed that trips that did not include the household respondent were missed at a higher rate than trips that did include the household respondent. For trips originally reported by proxy-response (the respondent was not on the trip), but collected by self-response (the respondent was on the trip) during the reinterview, a ratio was formed of reinterview trips divided by initial interview trips. For trips collected by self-response both during the original interview and reinterview (same respondent interviewed both times), the ratio was also formed by dividing reinterview trips by initial interview trips. The proxy adjustment factor was equal to this ratio for proxy response divided by this ratio for self-response. This factor was applied to all household trips that did not include the household respondent. It was also applied to all the corresponding person trips. This increase in the proxy-response factor relative to the self-response factor represents the missed trips due to the use of proxy respondents.

- The *recall factor* adjusted for trips forgotten by the respondent due to the length of time between the trip and

the date of the interview. They are more likely to correctly report a trip they took a month ago rather than one they took three months ago. Beginning in April, one-third of the trips collected for a given month was subject to one month of recall, another third was subject to two months of recall and one-third was a combination of three months of recall and less than one month of recall. Prior to April, all recall was greater than three months.

Identical trips were omitted from this factor since a respondent was not likely to forget a trip when the same trip is taken repeatedly. For the remaining trips, estimates of trips by month were tabulated by mode of travel and wave. The wave closest to a given month was chosen to represent the best estimate of the number of trips taken during that month. Trips from other waves were adjusted for that month to equal the estimate from the closest wave. For example, Wave 2 was interviewed in June so it had the best estimates for May trips. Waves 1 and 3 were adjusted to equal Wave 2 for the number of trips in May. The recall factor was applied to the same household trips (and their corresponding person trips) that were used to compute the factor.

- The *fatigue factor* adjusted for the missed trips that should have been collected in later cycles. Our estimates showed that fewer trips took place during the summer months (i.e., June, July and August) than during March, April, and May. The estimates also showed fewer trips in November and December than in September and October. These two trends seemed illogical. This phenomenon was attributed to respondent fatigue, i.e., some respondents tended to report fewer trips in later interviews in order to shorten their interview. This adjustment used a monthly distribution of trips calculated from previous surveys. The ratio of trips between the ATS and previous surveys was established for January through May trips. Most of these trips were collected during the first cycle. Since this was the first interview, the ATS trip estimates would not have been affected by the fatigue effect. Although some of the May trips were collected in the second cycle, the fatigue effect on these trips was accounted for by the recall factor. For each of the later months, the ratio of trips between the ATS and previous surveys was divided by this first-cycle ratio to yield the fatigue factor. This relative increase in the ratio of the two estimates for the later months compared with the first cycle ratio represents the missed trips due to fatigue. The appropriate fatigue factor was applied to all household trips and their corresponding person trips for June through December. The factor was applied to trips used to compute the factor, as well as, to the trips defined above that were excluded when the factor was computed.

**NONSAMPLING ERRORS**

Nonsampling errors are generally the largest source of error. These errors are attributable to a number of causes:

- incomplete coverage of all housing units and persons within households in the U.S.,
- households either can not be contacted or refuse to participate,
- items answered incorrectly or not answered at all,
- trips not reported by respondent
- trips reported incorrectly,
- approximations in the mileage estimation algorithm,
- incorrectly keyed data,
- imputing for missing data, and
- rounding.

Below is an explanation of the major sources of error and their impact on the ATS data.

**REINTERVIEW PROGRAM**

There were two parts to the ATS reinterview program: (a) a quality control falsification check and (b) a response error measurement of trip reporting. The sample for each part was selected independently.

The *falsification check* consisted of a 5 percent sample of ATS decentralized CATI/CAPI cases each month. The check was done by decentralized CATI/CAPI. The objective was to make sure the interviewer conducted the interview, properly classified interviews and noninterviews and did not falsify the data. During the reinterview the respondent was asked if they were contacted by an interviewer. The reinterviewer also verified the interview status from the original interview. Each interviewer was checked at least once.

The *response error measurement* consisted of a sample of about 650 completed interviews from each of the three waves. The interviews were conducted between August 1995 and March 1996. The objective was to see if respondents reported trips correctly. Most of the questions from the original interview were re-asked during the reinterview and differences in the main trips reported in the original interview and reinterview were reconciled. The results showed respondents may be less likely to forget trips taken by airplane, trips for business and pleasure, longer duration trips, and trips with more than one household member.

**COVERAGE ERROR**

Each home in the ATS sample represented a number of other homes. Because of incomplete sampling lists (i.e., under coverage), the homes in the survey did not represent all homes in the country. In particular, there was no coverage of building permit new construction built after 1993. In 80 percent of the states there is no building permit new construction built after 1992. These units are represented, in part, by other units whose permits were issued after April 1990.

In nonpermit issuing areas, the Census Bureau also missed non-permit new construction, new mobile homes, and new mobile home parks built between mid-1992 and January 1995. In 80 percent of the states the sample is lacking this coverage between mid-1991 and January 1995. In permit issuing areas, new mobile homes that moved into sites not covered in the 1980 census were missed.

To adjust for under coverage, the Census Bureau increased the household estimates proportionally for several key characteristics so that the published numbers of households match independent estimates. If the sample units do not adequately represent the missed units, some nonsampling error will be introduced into the data.

In addition to adjusting the ATS sample for whole households that were missed, another adjustment for missing people within households was necessary. Householders or their spouses were never assumed to be missed within interviewed households. As a result, the Census Bureau adjusted the weight on persons who were not household heads nor spouses to account for the remaining person under coverage. Assumptions about missed persons within households may not be correct (e.g., spouses may also be missed) which may introduce error into the estimates.

Within missed households, the household and person trips associated with the missed households were also assumed to be missed. A similar assumption was made for missed persons within households and for all single-person households. If more than one household member took a trip we assumed the trip would have been reported by the other household member. These assumptions may not be correct in some cases and will introduce some error into the estimates.

**D. Nonresponse Error**

There are two main types of nonresponse error: (a) noninterview error and (b) item nonresponse error. *Noninterview error* had three main sources. The first was centralized CATI cases the Census Bureau could not contact. This represented about 20 percent of the old sample and 35

percent of the new sample centralized CATI cases. The second was eligible occupied decentralized CATI/CAPI units who either could not or would not respond to the survey. This represented about 10 percent of the decentralized CATI/CAPI sample. The third was people in interviewed households for whom the Census Bureau could not collect trip data. This represented less than one-half of one percent of the people in sample households.

The centralized CATI portion of the sample had a particularly high noninterview rate. Normally, units not interviewed by centralized CATI are sent out to be interviewed by decentralized CATI/CAPI. To control the cost of the survey, the Census Bureau decided not to follow up these noninterviews and instead chose to adjust for them in the estimation process. Information was collected during the interview to help identify the decentralized CATI/CAPI units that centralized CATI would not have been able to interview. These decentralized units were used to represent the centralized CATI noninterviews. An additional source of nonsampling error could be from incorrectly identifying the decentralized CATI/CAPI units that centralized CATI would not have been able to interview between our old and new sample.

The following table summarizes the classification of units from both the centralized CATI and decentralized CATI/CAPI samples included in the adjustment separately for the old and new samples for Cycle 1. The numbers reflect the percentage of the overall sample from each of the four groups that were included in the adjustment.

The table below illustrates the difficulty the Census Bureau had in identifying decentralized CATI/CAPI units to include in the adjustment. Although specific situations (e.g., refusals) do not appear equally in both the centralized CATI and decentralized CATI/CAPI samples, the Census Bureau feels confident that the proper decentralized CATI/CAPI units were identified in the old sample. For the new sample, the Census Bureau probably missed some refusals.

The percentage of centralized and decentralized units included in the adjustment is very close for the old sample.

The differences in individual categories are more likely to be due to misclassified units rather than missed units. The CATI interviewer may not have assigned the same reason he or she could not interview the unit as a decentralized CATI/CAPI interviewer would have. For example, some centralized CATI units could not be classified and so were put in a “miscellaneous” category. These could be vacant or temporarily absent.

The percentage of centralized and decentralized units included in the adjustment appears to differ for the new sample. Differences are mainly attributable to the difference in refusal rates. The Census Bureau had a difficult time identifying decentralized CATI/CAPI households that would have been refusals for centralized CATI. Some of the other individual categories also appear to differ but those categories probably have units that were misclassified rather than missed. For example, since the new sample did not have its phone numbers screened, some centralized CATI cases that were actually vacant and temporarily absent units were classified as Bad/No Phone or miscellaneous noninterviews.

If the Census Bureau could not get all the information about all occupants they made several call-backs to the household to finish the interview. In these cases, only the final mode (i.e., personal visit or telephone) of interview used was recorded which could have resulted in more telephone interviews than should have been. This would have excluded interviewed decentralized CATI/CAPI units from the adjustment that should have been included because the decentralized CATI/CAPI units were telephone interviews rather than personal visit interviews. This, in turn, would have caused decentralized CATI/CAPI noninterviews to account for a disproportionately high number of centralized CATI noninterviews.

If the Census Bureau did not identify the correct units, some nonsampling error could be introduced into the estimates by this adjustment. Moreover, if the proportion of occupied units and traveling households in the centralized CATI noninterviews and in the decentralized CATI/CAPI

cases used to represent these noninterviews are not similar, some bias may have been added to some travel characteristics. It is likely that the Census Bureau excluded some interviewed decentralized CATI/CAPI units from the adjustment that should have been included.

This means ineligible units will get a higher weight than they should and interviewed units will get a lower weight resulting in an underestimate

**Table C-4**

Noninterview Reason	Old Sample Centralized CATI	Decentralized CATI/CAPI	New Sample Centralized CATI	Decentralized CATI/CAPI
Refusals	10.5	9.4	14.3	10.3
Other Noninterviewed				
Occupied Units	<.1	<.1	<.1	<.1
Temporarily Absent	1.3	2.1	1.9	3.4
Ineligible Units	.3	.5	.5	.7
Vacant	1.8	3.4	2.2	5.0
Bad/No Phone	2.7	2.6	10.0	8.5
Misc. Noninterviews	1.6		3.0	
Language	.3	.1	.5	.3
Total	18.5	18.1	32.5	28.4



of the number of trips. This is more of a problem for the new sample than the old sample. However, there is no way to measure the magnitude of this effect using data from the survey.

To represent the eligible occupied decentralized CATI/CAPI noninterviews, the Census Bureau used CATI and decentralized CATI/CAPI interviews with similar income and geography. If these interviews did not adequately represent the noninterviews, some nonsampling error was introduced into the estimates.

For non-interviewed people within interviewed households an assumption was made that the person's trip would have been reported if they took the trip with another household member. As a result, the Census Bureau only adjusted single-person household trips, and the corresponding person trips, to account for these non-interviewed people. If this assumption is incorrect, the ATS will underestimate the number of household and person trips. Finally, some interviewer notes indicated the household traveled but not detailed trip data was collected. In this case, trips from all other traveling households represented trips taken by these households.

*Item Nonresponse Error* - The main reason this type of error happens is because the respondents either do not know or do not want to give the answer to a question. Any item is subject to this error. Sensitive items, such as income, typically have the highest incidence of item nonresponse. We imputed all items for missing values.

The ATS imputed income for about 18 percent of the cases. Education was imputed for about 2.5 percent of the cases. Age was imputed for about 1 percent of the cases. All other demographic items (e.g., race, sex, etc.) had values imputed less than .5 percent of the time.

In some cases, the imputed data will not be the correct data. However, it is assumed that on average, the imputed data will adequately represent items for which no data were collected. Nonsampling error introduced by the imputation procedures will remain in the data.

Trip destinations (zip codes) were imputed for about 7.5 percent of trips (based on place names and state of origin provided by the respondent). The algorithm used the most populous city in the destination state as the destination. Depending on where this city is located relative to the state of origin, mileages could be consistently overestimated or underestimated. The number of trips to this metropolitan area may also be overstated.

In addition, the Census Bureau imputed return dates if there were 5 or more identical trips (i.e., trips with the same trip characteristics—destination, purpose, family travelers, etc.—as a trip already reported). This may distort trip

estimates by month; however trips by travel quarter should be accurate since there were up to three months between dates of interview when household members could report travel.

A number of edits designed to improve the data and eliminate inconsistencies were also included during the ATS processing. For example, the edits made demographic items such as race and ethnicity of children consistent with that of one or more of the parents. Also, the age of children had to be less than the parents age. The edits made sure trip data such as the leave and return dates were consistent with the number of nights the respondent spent traveling. These edits were done to try to improve the data. If the assumptions used to perform the edits are not correct some nonsampling error will be introduced into the data.

## E. MISREPORTING OF TRIPS

We know that respondents misreported trips for a number of reasons. This section describes the different reasons trips may have been misreported.

*Too Many Trips*—Respondents may have reported too many trips in some cases because the total number of nights they spent traveling during the year was greater than 365. Rather than drop trips, the Census Bureau adjusted the number of nights they spent on some trips. Too many trips may also have been reported because more than one family member reported the same trip.

*Recall*—Respondents have a more difficult time accurately reporting trips the farther the trip takes place from the date of interview. For example, they are more likely to correctly report a trip they took a month ago rather than one they took three months ago. The data verified this fact; there were consistently more trips reported for a month when the recall length was shorter. For example, there were more May trips reported in June interviews than in July interviews. An adjustment for trips lost due to recall error was made to the ATS data assuming the shortest recall trips were the most accurate. Estimates based on one month recall could also be missing trips. In addition, trips with one month recall are more likely to be affected by telescoping (see explanation below on *telescoping*) which would overestimate trips in the most current month. However, the Census Bureau believes making this adjustment made the trips estimates more accurate than not using this adjustment. The effect of this adjustment varied by mode of travel.

*Telescoping*—Telescoping is the reporting of a trip closer to the time of interview than when the trip actually took place. There are two types of telescoping: (a) internal and (b) external. Internal telescoping occurs when trips that

took place during the reference period are reported later than they actually occurred. For example, if the respondent is asked in April about trips they took between January and March, they may report February trips in March.

External telescoping occurs when trips that took place outside the reference period are reported to have taken place during the reference period. For example, if the reference period is January through March, the respondent may report some December trips. In the first interview, respondents were asked about trips completed after January 1, 1995. The Census Bureau hoped that the new year would have a bounding effect on the respondents and minimize the effect of external telescoping. During later interviews, the Census Bureau made the last 10 trips reported during the previous interview available to the interviewers. They used this information to make sure trips reported during the previous interview were not telescoped into the current reference period.

Telescoping impacts the data in three ways. First, it will artificially increase the estimate of trips because trips completed the previous year could be telescoped into the reference period for the first interview. In addition, a trip reported during a previous interview could be reported again. These would tend to overestimate trips. Second, the distribution of trips by month could be distorted by internal telescoping. Since the 1995 ATS sample was split into three parts with each part interviewed in a different month, this effect should even out over the year for all months except January - April. Finally, trips that took place in November and December of 1995 could have been telescoped into 1996 and would not have been reported. This would tend to underestimate trips in these months.

*Respondent Fatigue*—Our estimates showed that fewer trips took place during the summer months (i.e., June, July, and August) than during March, April, and May. The estimates also showed less trips took place in November and December than in September and October. These two trends seemed illogical. The Census Bureau believes this occurred because, after the first interview, respondents knew that if they reported less trips the interview would be shorter. This is known as respondent fatigue. The Census Bureau made an adjustment for trips lost due to respondent fatigue. The fatigue factor was not applied to trips in January–May. The Census Bureau assumed there was no respondent fatigue for the January–April trips since it was the first interview for the entire sample. The Census Bureau assumed any respondent fatigue in the May trips was accounted for in the recall adjustment.

These assumptions are probably not entirely accurate. Trips early in the year (e.g., January and February) may be overstated because of external telescoping from November

and December 1994. In addition, November and December trips for 1995 may be understated because of telescoping into the next year. This would distort trip distributions causing fatigue factors that are too low and underestimating trips. The adjustment assumes all trips were affected the same by respondent fatigue. This may not be true. Respondents may have reported trips with no stops but omitted trips with stops since they're more cumbersome to report. There is a chance that the Census Bureau underestimated certain types of trips such as these. As a result, some nonsampling error probably remains in the trip estimates.

Also, trips during November and December may be understated because of the Federal government shutdown that occurred during December 1995 and January 1996. The fatigue factor will be adjusting for some of this recall error. Since the recall adjustment was done by mode of travel but the fatigue factor was not, estimates of trips by mode of travel for these months may be distorted.

*Proxy Trip Reporting*—Proxy trip reporting means a trip was reported by someone who was not on the trip. This occurred because the Census Bureau only interviewed one respondent per household if the person was able to give information on travel for all the people in the household. The reinterview results showed that proxy trips were missed at a higher rate than trips reported by someone who took the trip (self-reported trips). The Census Bureau made an adjustment to account for trips missed due to proxy trip reporting. The impact of the adjustment depends on how well trips reported by proxy represent the missed proxy trips.

## F. MILEAGE ESTIMATION

The ATS interviewer asked about all trips over 75 miles one-way even though published reports include trips of 100 miles or more. Trips between 75 and 100 miles were included to make sure all trips over 100 miles were included since many people may not know the exact trip mileage. Respondents may have failed to report trips over 100 miles despite this buffer.

There are really two types of mileage estimation - one for trips taken by highway and one for other types of trips (e.g., trips by rail or air). Distances calculated for trips by rail and air are accurate because the number of different routes are limited and the origin and destination points are very specific. For trips taken by highway (e.g., car, truck, RV, etc.) the estimates are somewhat less accurate because the ATS did not ask each respondent to report the exact route driven for each trip reported.

Highway trip mileage was estimated using the zip code of the origin and the zip code of the destination and knowledge of frequently used highway routes. This was neither

the longest nor the shortest route and it usually favored rural roads and interstate and U. S. highways over more congested roads in urban areas.

#### **G. OTHER NONSAMPLING ERRORS**

In January 1995 the Census Bureau sent a letter to, and tried to call, sample units. About 25 percent of the sample was selected too late to call and did not receive a letter until March. This part of the sample may report fewer trips in January and February since they were not aware they would

be asked about 1995 trips until their first contact about the ATS was in March.

The ATS interviewing instrument could only pick up a certain number of trips due to space limitations. However, this number was quite large (99 trips per interview) and probably did not have a big impact on the data.

Finally, as in most surveys, the respondents may not give the correct answer because they do not know the answer or they misinterpret the question. Also, the field representative may record the answer incorrectly.